

DESCRIPTION

Multicomponent Packaging with Static Micromixer

The object of the invention is a packaging system with at least two separate storage chambers for in-situ preparation of formulations with at least two constituents that must be kept separated until they are used and with an integrated static micromixer with special disk-shaped mixer components.

With application products consisting of several substances, there often exists the risk that the products are not stable over a longer period of time, because some of the ingredients can undergo undesirable reactions with one another. For this reason, the products contain the most varied additives. The additives have the drawback that they make the product more expensive, that they can affect the application properties in an undesirable manner and, in particular, that they can cause side effects. To avoid these problems, the products can be offered in the form of multicomponent preparations wherein the incompatible ingredients are kept in different components which are mixed only just before use. Multicomponent preparations are also used in other applications for which suitable derivatives or precursors of the actual active ingredients are contained in a first formulation, and the active ingredients are released or formed only after said first formulation is mixed with a second formulation. Such applications are, for example, the delayed release or formation of pharmaceutical or cosmetic active ingredients, the formation of oxidation hair dyes from dye precursors and oxidants or the delayed curing of adhesives or trowelling compositions after the addition of appropriate curing agents.

For use, multicomponent preparations are often dispensed from separated packages or separated storage chambers of a single package and then mixed by shaking or manual agitation. Another possibility consists of conveying the separate formulations to a common dispensing opening through a suitable conveying system provided with appropriate means for mixing the components. These systems often present the drawback that the quality, consistency or efficacy of the mixture is unsatisfactory. In the case of viscous media, nonhomogeneities can arise and in the case of liquid, nonviscous media, in particular, the formation of finely dispersed mixtures such as emulsions or microemulsions is often not possible.

WO 00/54890, WO 00/54735 and SÖFW-Journal 128, vol. 11-2002, page 55, describe the use of static micromixers for in-situ mixing of cosmetic or pharmaceutical formulations just before use. The micromixer systems to be used are described in DE 195 11 603 (WO 96/30113), DE 197 46 583 (WO 99/20379), DE 197 46 584 (WO 99/20382), DE 197 46 585 (WO 99/20906) and DE 198 54 096 (WO 00/31422). The mixing process is based on guiding the components through repeatedly intersecting channels and subjecting said components to multiple shearing conditions of the communicating channels in the micromixer. Here, the difference in viscosity of the media to be mixed is critical: the greater this difference the worse is the emulsification process. In

particular, it is difficult to obtain good emulsions when viscous oils are used. The described mixing systems have relatively long mixing paths in which, in the resting position, the incompletely or partly mixed constituents remain, which in case of incompatibilities of the constituents is disadvantageous. Moreover, the relatively long micro-channels cause a relatively high pressure drop which must be compensated for by use of increased forces for the conveying of the constituents through the mixing system.

It is therefore desirable to provide additional, particularly improved systems for mixing two or more constituents just before use.

This objective is reached by way of a packaging system with at least two separate storage chambers for in-situ preparation of formulations consisting of at least two constituents that must be kept separated from one another until they are used. The packaging system is provided with at least one static micromixer containing at least one component in the form of a disk and wherein the disk

- has at least one inlet opening for the inflow of at least one feed stream into a linking channel disposed in the plane of the disk and at least one outlet opening for the outflow of the feed stream into a mixing zone disposed in the plane of the disk,
- wherein the inlet opening is linked with the outlet openings in a communicating manner by a linking channel disposed in the plane of the disk and
- wherein the linking channel before entering the mixing zone is divided by microstructure units into two or more part channels, the widths of the part channels being in the millimeter to submillimeter range and being smaller than the width of the mixing zone (5).

In the following, by the term "fluid" is meant a gaseous or liquid substance or a mixture of such substances that contains one or more dissolved or dispersed solid, liquid or gaseous substances. The term "mixing" comprises the processes of dissolving, dispersing and emulsifying. Hence, the term "mixture" comprises solutions, liquid-liquid emulsions, gas-liquid emulsions and solid-liquid dispersions.

The term "part channels" also includes division of the feed stream into part streams by built-in microstructure parts just before the outflow of said feed stream into the mixing zone. The dimensions, particularly the lengths and widths of these built-in parts, can be in the range of millimeters or preferably smaller than 1 mm. The part channels are preferably shortened to the length that is absolutely needed for flow control and, hence, for a certain throughput they require relatively low pressures. The part channels preferably do not intersect. The length-to-width ratio of the part channels is preferably in the range from 1:1 to 20:1, particularly from 8:1 to 12:1, and most preferably about 10:1. The built-in microstructure parts are preferably configured in such a way that the flow rate of the feed stream at the outlet into the mixing zone is greater than at the inlet into the linking channel and preferably also greater than the flow rate of the product stream through the

mixing zone.

The linking channels and part channels disposed on the disks can be provided in free form. The disks as well as each channel disposed thereon can vary in height, width and thickness so that they are also able to convey different media and different quantities. The basic shape of the disks can be of any desired kind. For example it can be round, for example circular, or else elliptical or angular, for example rectangular or square. The disk shape can also be optimized in terms of simple fabrication or in terms of minimum weight or minimum unused surface. The outlets of the part channels can be arranged in any desired manner from a straight line to any geometric form. For example, the outlet openings can be arranged on a circular line, particularly when the mixing zone is completely enclosed by the disk plane. Two or more than two constituents (A, B, C etc) can be conveyed in a disk and mixed in identical or different quantitative ratios. The part channels can be disposed at any angle to each other or relative to the line on which the outlets into the mixing zone are disposed. Several part channels, each conveying, for example, constituent A, can be arranged side by side, and in the adjacent section of the same disk there can be arranged side by side several part channels conveying, for example, constituent B. The constituents can, however, by means of additional through-holes and additional part channels, be configured so that constituents A, B etc alternate from part channel to part channel in the same disk.

At their entrance to the mixing zone, the part channels preferably have a width in the range from 1 μm to 2 mm and a depth in the range from 10 μm to 10 mm and most preferably a width in the range from 5 μm to 250 μm and a depth in the range from 250 μm to 5 mm.

The linking channel can have a variable width. Preferably, the ratio of the greatest width of the linking channel and/or the width of the inlet opening to the width of the part channels at their outlet into the mixing zone is greater than 2 and most preferably greater than 5. The ratio of the width of the mixing zone to the width of the part channels is preferably greater than 2 and most preferably greater than 5.

The disk-shaped components can be from 10 to 1000 μm thick. The height of the channels is preferably less than 1000 μm and most preferably less than 250 μm . The wall thickness of the built-in microstructure components and of the channel bottom is preferably less than 100 μm and most preferably less than 70 μm .

In a particular embodiment, at least one of the inlet or outlet openings or the mixing zone is completely enclosed by the plane of the disk. In this case, the openings are in the form of, for example, round or angular, for example rectangular, recesses. In the case of an enclosed mixing zone, the elliptical or circular shape is preferred. The part channels can taper off in the form of nozzles in the direction of the mixing zone. The part channels can be linear or bent in the shape of a spiral. The part channels can enter into the mixing zone at a right angle relative to the cir-

cumferential line of the mixing zone or at an angle different from 90° . When, in the event that the angle is different from a right angle, a stack of several mixing disks is formed, the disks with opposite deviation from a right angle are adjacent to each other. Similarly, in the event that the course of the part channels is spiral-shaped, when a stack is formed from several mixing disks, then disks with oppositely oriented direction of spiral rotation are preferably adjacent to each other.

The linking channel between the openings is preferably formed by an indentation. The inlet opening and/or outlet opening or the mixing zone, however, can also be disposed at the edge of the disk or be in the form of recesses at the edge of the disk.

In another particular embodiment, there are present at least two inlet openings for at least two different feed streams, each inlet opening being connected with the mixing zone through a linking channel. In this case, there are preferably two outlet openings for two different feed streams on opposite sides of the mixing zone, the mixing zone preferably being in a position completely enclosed within the disk plane.

Suitable materials of construction for the components are, for example, metals, particularly corrosion-resistant metals, such as, for example, stainless steel, as well as glasses, ceramic materials or plastic materials. The components can be fabricated by techniques for producing microstructures on surfaces, techniques that in and of themselves are known, for example by etching or milling of metals or by embossing or injection-molding of plastics

The static micromixer to be used according to the invention has a housing with at least 2 inlets for fluids and at least one outlet for fluids. In the housing are located at one or least two disk-shaped micromixer components arranged in a stack. Stacks can be formed from any number of disks, permitting a flow-through commensurate with the height of the stack. To ensure the same pressure throughout the mixer, in the case of greater lengths the fluid can be introduced at several points. Grooves or ribs in or on the disks can be used for the purpose of stacking and aligning. The disks are superposed on one another so that the inlet openings form subsidiary channels for introducing a particular feed stream and the outlet openings or the mixing zones together form a main channel for removing the product stream, the main channels and subsidiary channels extending through the stack. When the inlet openings are disposed as recesses at the edge of the disk, the housing wall can form the outwardly terminating part of the wall of a subsidiary channel. When the mixing zone is disposed as a recess at the edge of the disk, the housing wall can form the outwardly terminating part of the wall of the main channel. Overall, a micromixer can have, for example, at least 5, 10, 100 or even more than 1000 part channels and consist of a stack of disks having several part channels.

The packaging system has an appropriate arrangement for conveying the separately kept constituents through the micromixer. This could be a pumping arrangement actuated manually or electrically. Arrangements actuated by propellants or by pressure, however, are also possible.

Preferably, each part stream of a first feed A flowing from an outlet opening of a disk into the mixing zone is directly adjacent to a part stream of a second feed B flowing from an outlet opening of an adjacent disk into the mixing zone. In the mixing zone, the mixing takes place by diffusion and/or turbulence.

In another embodiment of the micromixer, the linking channels of the disks are formed by indentations. Before they end in the mixing zone, the linking channels are divided into part channels by microstructure units disposed on the disks. In an alternative embodiment, the linking channels of the disks are formed as recesses in the disks, the disks being arranged as intermediate disks between a cover disk and a bottom disk, and the linking channels, before opening into the mixing zone, being divided into part channels by microstructure units disposed on the cover disk and/or bottom disk.

The object of the invention is also an in-situ process for producing formulations consisting of at least two, preferably fluid, constituents just before use. At least two preferably fluid feeding streams that at first are kept separated are mixed with one another, the mixing being performed by use of at least one of the afore-described components of the invention, the static micromixer or packaging systems. Here, the flow rate of the feeding stream or feeding streams into the mixing zone is greater than the flow rate of the product mixture within the mixing zone. Particularly preferred are mixer configurations and flow rates giving rise to turbulence in the mixing zone, the mixing in the mixing zone being induced at least in part by turbulence.

The mixing process of the invention comprises, in particular, also homogenization processes, processes for the production of dispersions, emulsions or solutions as well as for the gassing or foaming of liquids. To this end, a continuous liquid phase is mixed with at least one insoluble fluid phase that is to be dispersed or with at least one soluble fluid phase by use of at least one component of the invention or of a static micromixer of the invention. The two phases can either be introduced through different subsidiary channels or one phase (preferably the continuous phase) is introduced through the main channel and the second phase through a subsidiary channel.

A particular embodiment relates to a process for mixing chemically reactive constituents whereby

- at least two fluid feed streams which at first are kept separated and which contain or consist of reactive constituents are mixed with one another and whereby
- during or after the mixing a chemical reaction between the constituents takes place spontaneously or is induced by supplying energy or by a suitable catalyst and whereby
- the mixing is carried out by use of at least one component of the invention or at least one

static micromixer of the invention.

To increase the capacity of the process of the invention, the number of channels in the disks can be increased or the number of the disks superposed on one another in a micromixer can be increased or two or more micromixers can be connected in series one after the other or in parallel next to each other. It is particularly advantageous if in this case a rough premix is made with a micromixer having large channel diameters and then with micromixers having increasingly smaller channel diameters.

In a particular embodiment, at least one of the packaging parts for the individual constituents is separately exchangeable. In this manner, the user can combine individually different active ingredient compositions. When a first constituent is not perfumed, it is possible, for example, by exchange of a second, perfumed constituent, to create in simple manner individual product scenting that is adapted to individual requirements.

In the following, exemplary embodiment of the components and micromixers of the invention will be explained by reference to the drawings.

- Fig. 1a-b shows mixing disks with two inlet openings for two feed streams and wherein the inlet openings and outlet openings are enclosed,
- Fig. 1c shows a mixing disk with a single inlet opening and wherein the inlet opening and outlet opening are enclosed,
- Fig. 1d shows a mixing disk wherein the inlet opening, flow-through opening and outlet opening are enclosed,
- Fig. 2a-c shows mixing disks with three inlet openings for up to three different feed streams and wherein the inlet openings and outlet openings are enclosed,
- Fig. 3a-b shows mixing disks with two inlet openings at the edge of the disk for two feed streams and with an enclosed outlet opening,
- Fig. 3c-d shows mixing disks with four inlet openings at the edge of the disk for up to four different feed streams and with an enclosed outlet opening,
- Fig. 4a-f shows mixing disks each with an enclosed inlet opening and flow-through opening for two feed streams and an outlet opening at the edge of the disk,
- Fig. 5a-b shows mixing disks each with one enclosed inlet opening and two enclosed flow-through openings for up to three different feed streams and an outlet opening at the edge of the disk,
- Fig. 6a shows a longitudinal section of the schematic structure of a static micromixer,
- Fig. 6b shows a mixing disk in an open housing,
- Fig. 7a-b shows mixing disks with enclosed inlet openings and flow-through openings and additional part channels, wherein different feed streams can flow through adjacent part channels,

- Fig. 8a,c shows mixing disks with enclosed inlet openings and flow-through openings and additional part channels, wherein different feed streams can flow through adjacent part channels,
- Fig. 8b shows a mixing disk with an enclosed inlet opening, three enclosed flow-through openings and additional part channels, wherein different feed streams can flow through adjacent part channels,
- Fig. 9 shows a micromixer with a housing and a stack of several mixing disks, and
- Fig 10 shows cross-sections through stacks of mixing disks with the molded element closing the mixing zone.

One embodiment is shown in Fig. 1a and Fig. 1b. The disks (1) each have two enclosed inlet openings (2). Each inlet opening (2) is connected with one linking channel (3) formed by an indentation in the plane of the disk. By a multiplicity of microstructure units (6), each linking channel (3) is divided into a multiplicity of part channels (7). Through the outlet openings (4), the part channels (7) open into an enclosed mixing zone (5). The outlet openings (4) are arranged on a circular line around the mixing zone (5). The mixing zone (5) and the inlet openings (2) are formed as through-holes in the disks. The microstructure units are bent, for example, in the form of spirals, the spirals in Fig. 1a and Fig. 1b having an opposite sense of rotation. The microstructure units, however, can also be linear or unbent. When the disks are round, they preferably have recesses (8) at the edge which can cooperate with fixing elements (14) in a housing (11) to prevent torsion or slipping of the disks. The disks, however, can also be angular, preferably quadrangular, for example in the shape of a square. In this case, the recesses and fixing elements may be omitted. Through the two inlet openings (2) two different feed streams can be introduced into the mixing zone (5) in one plane, the two outlet openings corresponding to the two different feed streams preferably being disposed opposite each other. A micromixer preferably has a stack of several components superposed on one another, with disks of the kind shown in Fig. 1a alternating with disks of the kind shown in Fig. 1b and giving rise to an arrangement consisting of an alternating layer structure ABAB etc. In this manner, two different feed streams can be fed to the mixing zone (5) directly adjacent and over and under one another. In the stack, the disks are superposed on one another in such a way that the inlet openings form subsidiary channels for introducing a particular feed stream, and the mixing zones form a main channel for removing the product stream. A fluid which later will constitute the continuous phase of the mixture, however, can also be introduced through the main channel.

Another embodiment is shown in Fig. 1c. The disk (1) has a single enclosed inlet opening (2) which is connected with a linking channel (3) formed by an indentation in the disk plane. The linking channel (3) is divided by a multiplicity of microstructure units (6) into a multiplicity of part channels (7). The part channels (7) open through the outlet openings (4) into the mixing zone (5). The outlet openings (4) are arranged on a circular line around the mixing zone (5). The mixing

zone (5) and the inlet opening (2) are configured as through-holes in the disk. The microstructure units are bent, for example, in the shape of a spiral. The microstructure units, however, can also be linear, unbent or have any other geometric shape. A micromixer preferably has a stack of several components superposed on one another. In the stack, the disks are disposed above one another in a manner such that the inlet openings form a subsidiary channel for introducing a feed stream, and the mixing zones form a main channel for removing the product stream. Through the main channel can be introduced one of the constituents to be mixed, preferably the fluid which later will form the continuous phase of the mixture. This embodiment is particularly well suited, for example, for gassing liquids, foaming liquids with a gas or preparing dispersions. To this end, the liquid to be treated with the gas or the dispersing medium is introduced through the central main channel and the gas or the substance to be dispersed is introduced through the subsidiary channel. Advantageously, the stack of disks can be configured as an alternating layer structure wherein disks with spiral-shaped microstructure units (6) of opposite sense of rotation are alternately disposed one above the other. It is also possible to use only a single type of disk. The microstructure units are then preferably linear and shaped so that the part channels form nozzles.

Another embodiment is shown in Fig. 1d. The disk (1) has an enclosed inlet opening (2), an enclosed mixing zone (5) and an enclosed flow-through opening (9). The inlet opening (2) is connected with a linking channel (3) formed by an indentation in the disk plane, which channel by a multiplicity of microstructure units (6) is divided into a multiplicity of part channels (7). The part channels (7) open through the outlet openings (4) into the mixing zone (5). The outlet openings (4) are arranged on a circular line around the mixing zone (5). The mixing zone (5), inlet opening (2) and flow-through opening (9) are configured as through-holes in the disk. The microstructure units are, for example, bent in the form of spirals. The microstructures units, however, can also be linear, unbent or have any other geometric shape. With additional built-in components (10) in the linking channel, the flow conditions in the linking channel (3) can be optimized. When the disks are round, they preferably have at their edge recesses (8) that can cooperate with fixing elements (14) in a housing (11) to prevent twisting or slipping of the disks. A micromixer preferably has a stack of several components of the kind shown in Fig. 1d and disposed above one another alternately twisted by 180°. In this manner, two different feed streams can be introduced into the mixing zone (5) directly adjacent above and under one another. In the stack, the disks are superposed on one another in a manner such that the inlet openings (2) and the flow-through openings (9) alternate and form two subsidiary channels for introducing two feed streams, the mixing zones forming a main channel for removing the product stream. A fluid that later will constitute the continuous phase of the mixture, however, can also be introduced through the main channel. Advantageously, the stack of disks can have a configuration with an alternating layer structure wherein disks with spiral-shaped microstructure units (6) of opposite sense of rotation are disposed alternately one above the other. A single type of disk, however, can also be used. The microstructure units are preferably linear and configured in such a way that the part channels form nozzles.

Figs. 2a to 2c show another embodiment. Each of the disks (1) has three enclosed inlet openings (2). Each inlet opening (2) is connected with a linking channel (3) formed by an indentation in the plane of the disk. Each linking channel (3) is divided by at least one microstructure unit (6) into at least two part channels (7). By means of a larger number of microstructure units, division into a higher number of part channels can be achieved. Through the outlet openings (4), the part channels (7) open into the mixing zone (5). The outlet openings (4) are arranged on a circular line around the mixing zone (5). The mixing zone (5) and the inlet openings (2) are configured as through-holes in the disks. The microstructure units can be in the form of spirals having a different sense of rotation or they can be linear. Through the three inlet openings (2), equal feed streams or up to three different feed streams can be introduced into the mixing zone (5) in one plane. A micromixer preferably has a stack of several components disposed one above another wherein different types of disks as shown in Figs. 2a, 2b and 2c alternate forming an alternating layer structure, for example ABCABC. In this manner, two different feed streams can be introduced into the mixing zone (5) directly adjacent and over and under one another. In the stack, the disks are disposed above one another so that the inlet openings form subsidiary channels for introducing a particular feed stream, and the mixing zones form a main channel for removing the product stream. A fluid which later will constitute the continuous phase of the mixture, however, can also be introduced through the main channel.

Another embodiment is shown in Fig. 3a and Fig. 3b. The disks (1) each have two inlet openings positioned at the edge of the disk. Each inlet opening (2) is connected with a linking channel (3) formed by an indentation in the plane of the disk. Each linking channel (3) is divided by a multiplicity of microstructure units (6) into a multiplicity of part channels (7). Through the outlet openings (4), the part channels (7) open into an enclosed mixing zone (5). The outlet openings (4) are arranged on a straight line. The mixing zone (5) is configured, for example, as a rectangular through-hole in the disks. The microstructure units are disposed, for example, at an angle to the direction of flow, the inclinations in Fig. 1a and 1b. extending in opposite directions. The microstructure units, however, can also have the same inclination or no inclination at all. The disks have an approximately quadrangular basic shape, but they can also have any other basic geometric shape (angular, round, elliptical etc). Through the two inlet openings (2), two different feed streams can be introduced into the mixing zone (5) in one plane, with the two outlet openings for the two different feed streams preferably disposed opposite each other. A micromixer preferably has a stack of several components disposed above one another, the disks of the kind shown in Fig. 3a alternating with disks of the kind shown in Fig. 3b and forming an alternating layer structure ABAB. In this manner, two different feed streams can be introduced into the mixing zone (5) directly adjacent and over and under one another. In the stack, the disks are disposed above one another so that the inlet openings together with the mixer housing form at the edge of the mixer subsidiary channels for introducing a particular feed stream, and the mixing zones form inside the mixers main channel for removing the product stream. A fluid that later will constitute the continuous phase of the mixture, however, can also be introduced through the main channel.

Another embodiment is shown in Fig. 3c and Fig. 3d. Each disk (1) has four inlet openings (2) positioned at the edge of the disk. Each inlet opening (2) is connected with a linking channel (3) formed by an indentation in the plane of the disk. Each linking channel (3) is divided by several microstructure units (6) into several part channels (7). Through the outlet openings (4), the part channels (7) open into an enclosed mixing zone (5). The outlet openings (4) are arranged on a circular line. The linking channels are bent into spiral shapes, the spirals in Fig. 3c and 3d having an opposite sense of rotation. The mixing zone (5) is configured as a through-hole in the disks. The microstructure units are, for example, straight, but they can also be slanted or bent like a spiral. The disks have an approximately quadrangular basic shape, but they can also have any other basic geometric shape (angular, round, elliptical etc). Through the four inlet openings (2), equal feed streams or up to four different feed streams can be introduced into the mixing zone (5) in one plane, with the outlet openings for the different feed streams preferably disposed opposite one another. A micromixer preferably has a stack of several components disposed above one another wherein disks of the kind shown in Fig. 3c alternate with disks of the kind shown in Fig. 3d and having a sense of rotation opposite to that of the spiral-shaped linking channels thus forming an alternating layer structure ABAB. In this manner, two different feed streams can be introduced into the mixing zone (5) directly adjacent and over and under one another. In the stack, the disks are disposed above one another so that the inlet openings together with the mixer housing form at the edge of the mixer subsidiary channels for introducing a particular feed stream, and inside the mixer the mixing zones form a main channel for removing the product stream. A fluid which later will constitute the continuous phase of the mixture, however, can also be introduced through the main channel.

Additional embodiments are shown in Fig. 4a to Fig. 4f. Each disk (1) has an enclosed inlet opening (2) and an enclosed flow-through opening (9). Each inlet opening (2) is connected with a linking channel (3) formed by an indentation in the plane of the disk. By a multiplicity of microstructure units (6), each linking channel (3) is divided into a multiplicity of part channels (7). Through outlet openings (4) arranged at the edge of the disks, the part channels (7) open into the mixing zone (5) disposed outside the plane of the disk. The outlet openings (4) can be arranged on straight lines (Fig. 4e, 4f) or on arc segments, the arc segments being convex (Fig. 4a, 4b) or concave (Fig. 4c, 4d). The inlet openings (2) and the flow-through openings (9) are configured as through-holes in the disks. The microstructure units can be parallel or they can be disposed at various angles to the flow direction preset by the linking channel. When the disks are round, they preferably have at their edge recesses (8) which can cooperate with fixing elements (14) in a housing (11) to prevent twisting or slipping of the disks. A micromixer preferably has a stack of several components disposed above one another, the disks of the kind shown in Fig. 4a alternating with disks of the kind shown in Fig. 4b, or disks of the kind shown in Fig. 4c alternating with disks of the kind shown in Fig. 4d, or disks of the kind shown in Fig. 4e alternating with disks of the kind shown in Fig. 4f, giving rise to an alternating layer structure ABAB. In this manner, two different feed streams can be fed to the mixing zone (5) directly adjacent and over and under one

another. Preferably, the angles at which the part channels open into the mixing zone are different relative to the circumferential line of the mixing zone in adjacent disks and most preferably have opposite deviations of 90° . In the stack, the disks are disposed over one another in a manner such that the inlet openings (2) and the flow-through openings (9) alternate and inside the mixer form subsidiary channels for introducing two feed streams. The mixing zone and a housing can form a main channel for removing the product stream, the mixing zone also possibly being open to the surroundings. The outwardly open configuration is particularly preferred if the mixture is to be dispensed as a spray or a foam, particularly if it is to be sprayed or foamed by use of a gas.

Other embodiments are shown in Fig. 5a and Fig. 5b. Each of the disks (1) has an enclosed inlet opening (2) and two enclosed flow-through openings (9). Each inlet opening (2) is connected with a linking channel (3) formed by an indentation in the plane of the disk. By a multiplicity of microstructure units (6), each linking channel (3) is divided into a multiplicity of part channels (7). Through outlet openings (4) arranged at the edge of the disks, the part channels (7) open into the mixing zone (5) disposed outside the plane of the disk. The outlet openings (4) can be arranged on straight lines (Fig. 5a) or on arc segments (Fig. 5b), the arc segments being convex or concave. The inlet openings (2) and the flow-through openings (9) are configured as through-holes in the disks. The microstructure units can be parallel or they can be disposed at various angles to the flow direction preset by the linking channel. When the disks are round, they preferably at their edge form recesses (8) which can cooperate with fixing elements (14) in a housing (11) to prevent twisting or slipping of the disks. A micromixer preferably has a stack of several components disposed above one another, the disks of the three different kinds shown in Fig. 5a alternating with those of the kind shown in Fig. 5b giving rise to an alternating layer structure ABCABC. In this manner, two different feed streams can be fed to the mixing zone (5) directly adjacent and over and under one another. Preferably, the angles at which the part channels open into the mixing zone (5) differ relative to the circumferential line of the mixing zone in adjacent disks, opposite deviations of 90° being particularly preferred. In the stack, the disks (1) are disposed over one another in a manner such that the inlet openings (2) and the flow-through openings (9) alternate and inside the mixer form three subsidiary channels for introducing up to three different feed streams. The mixing zone (5) and a housing can form a main channel for removing the product stream, the mixing zone also possibly being open to the surroundings. The outwardly open configuration is particularly preferred when the mixture is to be dispensed as a spray or foam and particularly when the mixture is to be sprayed or foamed by use of a gas.

Fig. 6a shows the schematic structure of an embodiment of a static micromixer in longitudinal section. A housing (11) is provided with fluid inlets (12a). The housing (11) contains a stack of several mixing disks (1) of the invention. The inlet openings and/or flow-through openings of the disks can be closed and opened by means of a preferably vertically displaceable closure (13a). With the closure, it is also possible to adjust the flow rate. The mixture can be removed from a mixing zone disposed within the housing through a suitable fluid outlet or it can be given off

directly from a mixing zone disposed outside the housing.

Fig. 6b shows the cross-section of a static mixer. Into a housing (11) is built a mixing disk (1) held in position by means of recesses (8) and fixing elements (14). The mixing disk is, for example, of the kind shown in Fig. 5a.

Other, preferred embodiments are shown in Figs. 7a-b and Figs. 8a-c. In these embodiments, the disks (1) have adjacent part channels (7) and (13) through which different feed streams can flow alternately so that different feed streams can be introduced into the mixing zone (5) directly adjacent in one plane.

Each of the disks (1) shown in Fig. 7a has an enclosed inlet opening (2), an enclosed mixing zone (5) and an enclosed flow-through opening (9). The inlet opening (2) is connected with a linking channel (3) formed by an indentation in the plane of the disk, said linking channel being divided into a multiplicity of part channels (7) by a multiplicity of microstructure units (6). Through the outlet openings (4), the part channels (7) open into the mixing zone (5). The outlet openings (4) are arranged on a circular line around the mixing zone (5). The mixing zone (5), the inlet opening (2) and the flow-through opening (9) are configured as through-holes in the disk. Into the microstructure units (6) are integrated additional part channels (13) configured as indentations and which are shielded against the linking channel (3) and open into the mixing zone (5). The part channels (7) and the additional part channels (13) are alternately disposed adjacent to each other.

The disks are provided with additional through-holes (12), the number of the through-holes (12) and the number of the additional part channels (13) being identical. The through-holes (12) are arranged so that when a disk (1) is placed on a second disk (1) twisted by 180° , said through-holes are disposed above the additional part channels (13) of the disk that is positioned underneath. A feed stream flowing through the inlet opening (2) into the linking channel (3) can flow through the through-holes (12) into an additional part channel (13) of a disk positioned underneath. The angle formed between the adjacent part channels (7) and (13) and the angle formed toward the circumferential line of the mixing zone can be different. In Fig. 7a, the angles of the part channels (7) and of the additional part channels (13) relative to the circumferential line of the mixing zone (5) have opposite deviations of 90° . As a result, the outlet openings of each two part channels form a pair. In this manner, two different feed streams can be introduced on top of each other. The part channels, however, can also run parallel, at right angles or inclined toward the mixing zone. Fig. 7a shows next to each other two identical disks (1) twisted by 180° . Fig. 7b shows schematically two superposed disks twisted by 180° . A micromixer preferably has a stack of several superposed components, wherein disks of the kind shown in Fig. 7a twisted by 180° are alternately superposed on one another. In this manner, two different feed streams can be fed to the mixing zone (5) both directly adjacent and over and under one another and also directly adjacent and next to each other. In the stack, the disks are disposed above one another so that the inlet openings (2) and the flow-through openings (9) alternate and form two subsidiary channels

for introducing two feed streams, and the mixing zones form a main channel for removing the product stream. A fluid that later will constitute the continuous phase of the mixture, however, can also be introduced through the main channel. Moreover, the disks are disposed above one another so that each additional through-hole (12) of a disk is connected in communicating manner with one corresponding additional part channel (13) of an adjacent disk.

Fig. 8a shows an embodiment similar to that of Fig. 7a the difference being that the part channels (7) and the additional part channels (13) lead to the mixing zone (5) in parallel and inclined at identical angles. In Fig. 8a, the disk on the left differs from the disk on the right in that the angle formed between the part channels (7) and (13) and the circumferential line of the mixing zone (5) has an opposite deviation of 90° . A micromixer preferably has a stack of several superposed components wherein the left and the right disks shown in Fig. 8a alternate giving rise to an alternating layer structure ABAB. In this manner, two different feed streams can be introduced into the mixing zone (5) directly adjacent and over and under each other at opposite angles.

Fig. 8c shows an embodiment similar to that of Fig. 8a the difference being that the part channels (7) and the additional part channels (13) lead to the mixing zone (5) in parallel and vertically. A micromixer preferably has a stack of several superposed components wherein the left and right disks of the kind shown in Fig. 8c alternate resulting in an alternating layer structure ABAB. In the stack, the disks are superposed on one another so that the inlet openings (2) and the flow-through openings (9) alternate and form two subsidiary channels for introducing two feed streams, and the mixing zones form a main channel for removing the product stream. Moreover, the disks are superposed on one another so that each additional through-hole (12) of a disk is connected in communicating manner with a corresponding additional part channel (13) of an adjacent disk. In this manner, two different feed streams can be introduced into the mixing zone (5) both directly adjacent and over and under each other and directly adjacent and next to each other.

Another embodiment is shown in Fig. 8b. A disk (1) has an enclosed inlet opening (2), three enclosed flow-through openings (9) and an enclosed mixing zone (5). The inlet opening (2) is connected with a linking channel (3) formed by an indentation in the plane of the disk and which by a multiplicity of microstructure units (6) is divided into a multiplicity of part channels (7). Through the outlet openings (4), the part channels (7) open into the mixing zone (5). The outlet openings (4) are arranged on a circular line around the mixing zone (5). The mixing zone (5), the inlet opening (2) and the flow-through opening (9) are configured as through-holes in the disk. Into the microstructure units (6) are integrated in indented manner additional part channels (13) which are shielded against the linking channel (3) and which open into the mixing zone (5). The part channels (7) and the additional part channels (13) are disposed alternately adjacent to each other. The disks have additional through-holes (12), the number of the through-holes (12) and the number of the additional part channels (13) being identical. The through-holes (12) are arranged so that when a disk (1) twisted by 90° is placed on a second disk (1) the said through-holes are

positioned above the additional part channels (13) of the disk located underneath. A feed stream flowing through the inlet opening (2) into the linking channel (3) can flow through the through-holes (12) into the additional part channel (13) of a disk positioned below. The angle formed between the adjacent part channels (7) and (13) and the angle formed toward the circumferential line of the mixing zone can be different. In Fig. 8b the angles of the part channels (7) toward the circumferential line of the mixing zone (5) have an opposed deviation of 90° compared to the angles formed by the additional channels (13). As a result, the outlet openings of each two part channels form a pair. In this manner, two different feed streams can be introduced on top of each other. The part channels, however, can also run parallel at a right angle or inclined toward the mixing zone. A micromixer preferably has a stack of several superposed components, the disks of the kind shown in Fig. 8b being disposed above one another in any order and each being twisted by 90° , 180° or 270° . In this manner, different feed streams can be introduced into the mixing zone (5) either directly adjacent and over and under one another or directly adjacent and next to each other. Overall, up to four different feed streams can be mixed by means of the micromixer. In the stack, the disks are superposed on one another so that the inlet openings (2) and the flow-through openings (9) alternate and form a total of four subsidiary channels for introducing up to four feed streams, and the mixing zones form a main channel for removing the product stream. A fluid that later will constitute the continuous phase of the mixture, however, can also be introduced through the main channel. Moreover, the disks are superposed on one another so that each additional through-hole (12) of a disk is connected in communicating manner with the corresponding additional part channel (13) of an adjacent disk.

Fig. 9 shows as an example, in an exploded view, a possible embodiment of a micromixer usable according to the invention. A housing (11) contains a stack of components of the invention in the form of disks (1). Shown as an example is a stack of several disks of the kind depicted in Fig. 8a, but other disks of the invention can also be used, in which case optionally the shape of the housing, the number and position of the inlets and outlets of the fluid etc must be correspondingly adapted. The disks (1) are positioned so that the recesses (8) cooperate with the fixing elements (14) to prevent the twisting of the disks. The housing has two fluid inlets (12a) for introducing the feed streams. The housing can be closed with a cover (15) provided with a fluid outlet (16).

Fig. 10 shows additional embodiments wherein, in the resting position, the mixing zone (5) or the mixing space formed by several disk-shaped components (1) is filled by a closure (13a) in the form of a molded element which closes off the outlet openings (4) (Fig. 10 a, c, e, g). By means of an appropriate mechanism, for example when the dispenser means of the packaging system is actuated, the molded element (13a) is removed from the mixing zone (5) entirely or partly and the outlet openings (4) are opened entirely or partly (Fig. 10 b, d, f, h). The actuation can occur by preselectable pressure and/or by forced mechanical guidance. The molded element can be configured so that during the dosing and mixing process, by means of a pressure build-up and/or geometric baffles, it produces enhanced turbulence with improved mixing quality. At the end of

the dosing, the molded element can again completely close off the mixing zone. The mixer is thus free of mixture residues which otherwise could react and spoil. The molded element can be integrated into the packaging system in such a way that in the resting position it provides a closure toward the outside thus giving rise to a smooth, easy-to-keep clean surface (Fig. 10 a b). In the resting position, however, the molded element, can also protrude slightly outward (Fig. 10 c). In this case, should it stick as a result of being pressed into the housing, it can readily be unstuck. The molded element can have any shape adapted to the mixing zone (5), for example it can be cylindrical or column-shaped in the case of mixing zones with an opening which remains constant within a stack (Fig. 10 a-f) or it can be conical (Fig. 10 g, h) in the case of mixing zones with openings that within the stack become narrow toward the product delivery opening.

Fig. 11 shows a two-constituent container with an integrated stack of micromixer disks. In an outer container (17) that can be closed with a cover (15) there are disposed two internal containers (18a) and (18b) wherein two compositions to be kept separated can be stored until they are to be used. By actuating a suitable delivery system, the compositions are conveyed through the fluid inlets (12a) to a stack of disk-shaped mixer components (1) and mixed. The ready-to-use mixture exits through the fluid outlet (16).

An advantage of the packaging system of the invention lies in that constituents with different viscosities can also be readily mixed. One embodiment therefore concerns a packaging system containing at least two separately kept liquid constituents with different viscosities, namely the ratio of the viscosities of the constituent with higher viscosity to those of the constituent with lower viscosity is greater than 1, preferably greater than 1.5 and particularly from 2 to 100 (measured at 25°C).

The packaging system is primarily suited for use in processes for mixing just before use constituents which as a finished mixture are chemically or physically unstable (emulsions, dispersions, perfume-containing compositions and thickened systems such as gels, emulsions with pharmaceutical active ingredients which in the finished emulsion are not storage-stable etc.). Over the short time of application, the prepared mixtures are sufficiently stable to meet particular use requirements. As long as they are kept separated, the individual constituents can be stabilized by an appropriate selection of the pH or of other effective stabilizers.

Possible applications for cosmetic preparations are, for example

- in-situ preparation of shampoos, hair treatment preparations, hair lotions or skin lotions;
- preparing mixtures of dye precursors and oxidants for hair colorants; in this case, the finished mixture can be applied directly to the hair with the aid of an applicator without the conventional manual mixing in a bowl, as in the past;
- preparing mixtures of reactive solutions with thickeners, particularly viscous preparations containing oxidants and thickeners for blonding hair or fixing permanent waves;

- producing foams by chemical release of a gas (for example CO₂ from a carbonate-containing or hydrogen carbonate-containing constituent and an acidic constituent);
- foams for hair or skin treatment from a surfactant-containing liquid constituent and a gaseous constituent;
- mixing of end products to achieve special effects, for example color-change products which after mixing give rise to a time-delayed chemical color-change reaction, the time delay being adjusted to give an optimum application period for the product, for example a hair treatment preparations;
- producing gels from low-viscosity starting constituents.

Possible uses for pharmaceutical preparations are, for example

- to prepare water-sensitive systems by mixing a water-free and a water-containing constituent only just at the instant of use;
- to prepare ointments, emulsions, lotions etc fresh just at the instant of use, it being possible to reduce the amount of, or omit, the emulsifiers otherwise commonly needed for long-term emulsion stability and thereby enhancing compatibility and reducing side effects.

Possible uses in adhesives technology are, for example,

- to produce multiconstituent systems at the instant of use, in which case the manual mixing of a first, curable constituent A and a second, curing agent-containing constituent B is omitted; at the end of the mixing process, the mixing chamber is kept free of curable mixture residues by closing it with a molded element,

Possible uses for foodstuffs are, for example,

- to produce mayonnaise, mustard etc at the instant of use;
- to homogenize milk, milk products etc;
- to produce cream without mechanical beating.

In the process of the invention, one of the phases to be mixed is usually liquid, and the second phase and optionally additional phases can be liquid, solid or gaseous. The two phases to be mixed are brought together in a micromixer so that the constituents of the mixture are mixed in the mixing zone at the outlet from the supplying channels. The process of the invention is particularly well suited to preparing just before use colorants, adhesives, foodstuffs, pharmaceutical agents, cosmetic agents or building materials and particularly to producing emulsion-forming preparations containing at least one hair-care or skin-care cosmetic, dermatological or pharmaceutical active ingredient, hair-firming agents, hair coloring agents or permanent wave lotions. In the case of cosmetic uses, at least one constituent contains a hair-cosmetic or skin-cosmetic constituent. This constituent can be, for example, a hair-care substance, a hair-coloring substance, a hair-firming substance, a substance protecting the skin and/or hair from light, a fragrance material, a skin-care substance, an antidandruff constituent, a hair-cleaning and/or skin-cleansing material or a

preservative. Typical amounts of active ingredient are in this case 0.05 to 20 wt.% and preferably 0.14 to 10 wt.%.

Preferably, one of the constituents to be mixed is an aqueous, liquid phase and the other constituent is a hydrophobic, liquid or water-sensitive substance-containing phase, or the constituents contain substances that on contact with one another react chemically or change the physical consistency of the mixture.

In the case of dispersions, the amount of the phase to be homogenized in the finished emulsion or suspension depends on the requirements of the end product to be prepared. For hair treatments, the lipophilic phase can amount to, for example, from 2 to 10 wt.% or for creams, for example hair-coloring creams, even up to about 50 wt.%. The homogenization can be carried out without an emulsifier. However, an emulsifier or a surfactant can be present as a dispersing aid. The finished composition can contain the dispersing aid in an amount from 0.5 to 30 wt.%. Suitable emulsifiers are the nonionic, anionic, cationic, amphoteric or zwitterionic emulsifiers. Suitable emulsifiers are, for example, those indicated in the "International Cosmetic Ingredient Dictionary and Handbook", 7th edition, volume 2, in the section on "Surfactants", and particularly in the subsection on "Surfactants - Emulsifying Agents". Nonionic emulsifiers are, for example, ethoxylated fatty alcohols, ethoxylated nonylphenols, fatty acid mono- and diglycerides, ethoxylated and hydrogenated or nonhydrogenated castor oil, fatty acid alkanolamides and ethoxylated fatty esters. Cationic emulsifiers are, for example, long-chain quaternary ammonium compounds such as those known under the CTFA designation "Quaternium", such as, for example, alkyltrimethylammonium salts or dialkyldimethylammonium salts with C₈-C₂₂-alkyl groups. Anionic emulsifiers are, for example, the fatty alcohol sulfates, alkyl ether sulfates and alkylbenzenesulfonates. Amphoteric emulsifiers are, for example, the betaines such as fatty amide alkylbetaines, sulfobetaines and C₈-C₂₂-alkylbetaines.

The particle diameter of the dispersed phase is preferably less than 1 µm and particularly less than 0.2 µm. In another embodiment, the channel dimensions, the micro components of a micro-mixer and the flow and pressure conditions are selected so that the emulsification of the aqueous and hydrophobic phase produces a microemulsion or a nanoemulsion, meaning that the particle size is 100 nm or less.

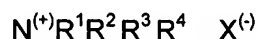
According to the process of the invention, the dispersion of an aqueous phase with an immiscible, hydrophobic phase can take place with or without an emulsifier. A special advantage of the process is that no emulsifier, or a substantially smaller amount of emulsifier, is needed to obtain an emulsion or dispersion of a certain viscosity which needs to be stable only over a short period of time, namely only during the time of application. As a result, the irritation potential is reduced and the skin compatibility is improved. If emulsifiers are entirely omitted, metastable dispersions are formed which have prolonged stability compared to the dispersions prepared by the

conventional processes. Another object of the invention therefore is a process for producing a preparation in dispersed form whereby just before use a hydrophobic phase is mixed with an aqueous phase in a micromixer without the use of an emulsifier.

Another object of the invention is a process for producing cleaning agents, particularly hair, skin or textile cleaning agents, the composition of which contains at least one deterative surfactant and optionally other additives. The hair or skin cleaning compositions are shampoos, shower bath compositions, shower gels, bathing preparations etc. In a preferred embodiment, the first constituent contains at least one anionic deterative surfactant in an aqueous phase and a second constituent contains at least one active care agent which on prolonged storage is not compatible with the first constituent, for example an oil or a cationic care agent. The term "aqueous phase" comprises water and mixtures of water and a water-soluble solvent such as a lower alcohol, for example ethanol or isopropanol, or a polyol such as ethylene glycol, diethylene glycol, butylene glycol or glycerol, but preferably water. The preferred anionic surfactants are alkyl ether sulfates. Suitable alkyl ether sulfates contain an alkyl group with 8 to 22 and preferably 10 to 16 carbon atoms and have a degree of ethoxylation from 1 to 20 and preferably from 1 to 4. Particularly preferred are lauryl ether sulfates. Suitable counterions are alkali metal ions or alkaline earth metal ions, for example sodium, magnesium or ammonium ions. Suitable alkyl ether sulfates are, for example, indicated among the surfactants in the "International Cosmetic Ingredient Dictionary and Handbook", 7th edition, volume 2, in the section on "Alkyl Ether Sulfates".

The cationic care agent used in the second constituent of the cleaning agent is a substance which because of its cationic groups or groups that can be converted into cations, particularly protonated amino groups or quaternary ammonium groups, has substantivity for human hair. The cationic or cation-active hair-care substance is preferably selected from among cationic polymers, cationic surfactants, cationic silicone compounds, cationically derivatizable proteins, cationically derivatizable protein hydrolyzates and betaine, each with at least one cationic or cation-active group. Good hair-care efficacy is achieved when at least one cationic polymer is combined with at least one cationic surfactant. In addition, at least one cationic silicone compound, particularly a terminal diquaternary polydimethylsiloxane, may be present.

Suitable cationic surfactants are those containing a quaternary ammonium group. In particular, suitable cationic surfactants are those of general formula



wherein R^1 to R^4 independently of each other denote aliphatic groups, aromatic groups, alkoxy groups, polyoxyalkylene groups, alkylamido groups, hydroxyalkyl groups, aryl groups or alkylaryl groups with 1 to 22 carbon atoms, and at least one of the R^1 to R^4 groups contains at least 8 carbon atoms, and X^- denotes an anion, examples being a halogen, acetate, phosphate, nitrate or

alkyl sulfate and preferably a chloride. Besides the carbon atoms and hydrogen atoms, the aliphatic group can also contain compounds with cross-linking or other groups, for example additional amino groups. Examples of suitable cationic surfactants are the chlorides or bromides of alkyldimethylbenzylammonium salts, alkyltrimethylammonium salts, for example cetyltrimethylammonium chloride or bromide, tetradecyltrimethylammonium chlorides or bromides, alkyldimethylhydroxyethylammonium chlorides or bromides, dialkyldimethylammonium chlorides or bromides, alkylpyridinium salts, for example laurylpyridinium chloride or cetylpyridinium chloride, alkylamidoethyltrimethylammonium ether sulfates and compounds with a cationic character, such as the amine oxides, for example alkylmethylaniline oxide or alkylaminoethyltrimethylamine oxide. Cetyltrimethylammonium chloride is particularly preferred.

Cationic or cation-active polymers are hair-care or hair-conditioning polymers. Suitable cationic polymers preferably contain quaternary ammonium groups. The cationic polymers can be homopolymers or copolymers wherein the quaternary nitrogen groups are contained either in the polymer chain or preferably as substituents on one or several of the monomers. The ammonium groups-containing monomers can be copolymerized with non-cationic monomers. Suitable cationic monomers are unsaturated, free-radical-polymerizable compounds bearing at least one cationic group, particularly ammonium-substituted vinyl monomers, for example trialkylmethacryloxyalkylammonium, trialkylacryloxyalkylammonium, dialkyldiallylammonium and quaternary vinylammonium monomers with cyclic, cationic nitrogen-containing groups such as pyridinium, imidazolium, or quaternary pyrrolidone groups, for example alkylvinylimidazolium, alkylvinylpyridinium or alkyl-vinylpyrrolidone salts. The alkyl groups of these monomers are preferably the lower alkyl groups, for example C₁- to C₇-alkyl groups and most preferably C₁- to C₃-alkyl groups. The monomers containing ammonium groups can be copolymerized with non-cationic monomers. Suitable comonomers are, for example, acrylamide, methacrylamide, alkyl- and dialkylacrylamide, alkyl- and dialkylmethacrylamide, alkyl acrylate, alkyl methacrylate, vinylcaprolactone, vinylcaprolactam, vinylpyrrolidone, vinyl esters, for example vinyl acetate, vinyl alcohol, propylene glycol or ethylene glycol, the alkyl groups of these monomers preferably being C₁- to C₇- alkyl groups and most preferably C₁- to C₃- alkyl groups.

Cationic polymers with quaternary amino groups are, for example, the polymers described in the CTFA Cosmetic Ingredient Dictionary under the designation Polyquaternium such as methylvinylimidazolium chloride/vinylpyrrolidone copolymer (Polyquaternium-16) or the quarternized vinylpyrrolidone/dimethylaminoethyl methacrylate copolymer (Polyquaternium-11) as well as quaternary silicone polymers or oligomers, for example silicone polymers with quaternary end groups (Quaternium-80). Suitable among the cationic polymers is, for example, the vinylpyrrolidone/dimethylaminoethyl methacrylate methosulfate copolymer marketed under the commercial names Gafquat® 755 N and Gafquat® 734 and of which Gafquat® 755 N is particularly preferred. Other cationic polymers are, for example, the copolymer of polyvinylpyrrolidone and imidazolium methochloride marketed under the commercial name LUVIQUAT® HM 550, the terpolymer

of dimethyldiallylammonium chloride, sodium acrylate and acrylamide marketed under the commercial name Merquat® Plus 3300, the terpolymer of vinylpyrrolidone, dimethylaminoethyl methacrylate and vinylcaprolactam marketed under the commercial name Gaffix® VC 713 and the vinylpyrrolidone/methacrylamidopropyltrimethylammonium chloride copolymer marketed under the commercial name Gafquat® HS 100.

Suitable cationic polymers derived from natural polymers are the cationic derivatives of polysaccharides, for example the cationic derivatives of cellulose, starch or guar. Also suitable are chitosan and chitosan derivatives. The cationic polysaccharides have the general formula



wherein

G is an anhydroglucose group, for example starch anhydroglucose or cellulose anhydroglucose;

B is a divalent linking group, for example alkylene, oxyalkylene, polyoxyalkylene or hydroxyalkylene;

R⁵, R⁶ and R⁷ independently of each other denote alkyl, aryl, alkylaryl, arylalkyl, alkoxyalkyl or alkoxyaryl each with up to 18 carbon atoms, the total number of carbon atoms in the R⁵, R⁶ and R⁷ groups preferably being at the most 20;

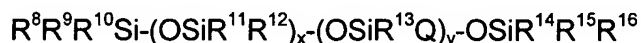
X is a common counterion, has the same meaning as hereinabove and preferably denotes a chloride.

A cationic cellulose is marketed by Amerchol under the name Polymer JR and has the INCI designation Polyquaternium-10. Another cationic cellulose has the INCI designation Polyquaternium 24 and is marketed by Amerchol under the commercial name Polymer LM-200. A suitable cationic guar derivative is marketed under the commercial name Jaguar® R and has the INCI designation Guar Hydroxypropyltrimonium Chloride. Particularly preferred cation-active substances are chitosan, chitosan salts and chitosan derivatives. The chitosans to be used according to the invention are completely or partly deacetylated chitins. The molecular weight of the chitosans can vary within a wide range, for example from 20,000 to about 5 million g/mol. Suitable, for example, is a chitosan with a low molecular weight of 30,000 to 70,000 g/mol. Preferably, however, the molecular weight is higher than 100,000 /mol and most preferably it is between 200,000 and 700,000 g/mol. The degree of deacetylation is preferably from 10 to 99% and most preferably from 60 to 99%. A suitable chitosan is marketed, for example, by Kyowa Oil & Fat, Japan, under the commercial name Flonac®. It has a molecular weight of 300,000 to 700,000 g/mol and is 70 to 80% deacetylated. A preferred chitosan salt is chitosonium pyrrolidone carboxylate which is marketed, for example, by Amerchol, USA, under the commercial name Kytamer® PC. The chitosan in this product has a molecular weight of about 200,000 to 300,000 g/mol and is 70 to 85% deacetylated. Suitable chitosan derivatives are the quaternized, alkylated or hydroxyalkylated derivatives, for example hydroxyethyl-, hydroxypropyl- or hydroxybutylchitosan. The chitosans or chitosan derivatives are preferably used in the neutralized or

partly neutralized form. The degree of neutralization of the chitosan or chitosan derivative is preferably at least 50% and most preferably between 70 and 100%, based on the number of free base groups. In principle, the neutralization agent can be any cosmetically compatible inorganic or organic acid, for example, among others, formic acid, malic acid, lactic acid, pyrrolidonecarboxylic acid, hydrochloric acid among which pyrrolidonecarboxylic acid and lactic acid are particularly preferred.

Preferred are polymers that possess sufficient solubility in water or in water/alcohol mixtures so as to be able to dissolve completely in the hydrophilic phase of the invention. The cationic charge density is preferably 0.2 to 7 meq/g or 0.4 to 5 meq/g and particularly 0.6 to 2 meq/g. Usually, only small amounts of cationic polymers with a low cationic charge density (for example up to 3 meq/g) can be incorporated into current hair-care shampoos in a stable manner. By contrast, according to the invention it is possible to add larger amounts of these slightly cationized polymer or polymers with a higher degree of cationization (for example > 3 meq/g).

Suitable cation-active silicone compounds preferably contain either at least one amino group or at least one ammonium group. Suitable silicone polymers with amino groups are known under the INCI designation Amodimethicone. They are polydimethylsiloxanes with aminoalkyl groups. The aminoalkyl groups can be lateral groups or terminal groups. Suitable aminosilicones are those of general formula



wherein

R^8 , R^9 , R^{14} and R^{15} independently of each other are equal or different and denote C_1 - to C_{10} -alkyl, phenyl, hydroxy, hydrogen, C_1 - to C_{10} -alkoxy or acetoxy, preferably C_1 - C_4 -alkyl and most preferably methyl;

R^{10} and R^{16} independently of each other are equal or different and denote $-(CH_2)_a-NH_2$ wherein a equals 1 to 6, C_1 - to C_{10} -alkyl, phenyl, hydroxyl, hydrogen, C_1 - to C_{10} -alkoxy or acetoxy, preferably C_1 - C_4 -alkyl and most preferably methyl;

R^{12} and R^{13} independently of each other are equal or different and denote hydrogen, C_1 - to C_{20} -hydrocarbon possibly bearing O-atoms or N-atoms, preferably C_1 - to C_{10} -alkyl or phenyl and most preferably C_1 - to C_4 -alkyl, particularly methyl;

Q denotes $-A-NR^{17}R^{18}$ or $-A-N^+R^{17}R^{18}R^{19}$ wherein A stands for a divalent C_1 - to C_{20} -alkylene linking group that may also contain O-atoms and N-atoms as well as OH- groups, and R^{17} , R^{18} and R^{19} independently of each other are equal or different and denote hydrogen, C_1 - to C_{22} -hydrocarbon, preferably C_1 - to C_4 -alkyl or phenyl. Preferred groups for Q are

$-(CH_2)_3-NH_2$, $-(CH_2)_3NHCH_2CH_2NH_2$, $-(CH_2)_3OCH_2CHOHCH_2NH_2$, ,

$-(CH_2)_3N(CH_2CH_2OH)_2$, $(CH_2)_3-NH_3^+$ and

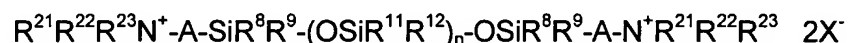
$-(CH_2)_3OCH_2CHOHCH_2N^+(CH_3)_2R^{20}$ wherein R^{20} denotes a C_1 - to C_{22} -alkyl group that may also

bear OH groups;

x denotes a numeral between 1 and 10,000 and preferably between 1 and 1,000 and

y denoted a numeral between 1 and 500 and preferably between 1 and 50.

The molecular weight of the aminosilicones is preferably between 500 and 100,000. The amount of amine (meq/g) is preferably in the range from 0.05 to 2.3 and most preferably from 0.1 to 0.5. Particularly preferred are silicone polymers with two terminal quaternary ammonium groups. These compounds are known under the INCI designation Quaternium-80. They are polydimethylsiloxanes with two terminal alkylammonium groups. Suitable quaternary aminosilicones are those of general formula



wherein

A has the same meaning as indicated hereinabove and preferably stands for

$-(CH_2)_3OCH_2CHOHCH_2N^+(CH_3)_2R^{20}$ wherein R^{20} denotes a C_1 - to C_{22} -alkyl group that may also bear OH groups;

R^8 , R^9 , R^{11} and R^{12} have the same meaning as indicated hereinabove and preferably stand for methyl;

R^{21} , R^{22} and R^{23} independently of each other denote C_1 - to C_{22} -alkyl groups that may bear hydroxyl groups and wherein at least one of the groups has at least 10 carbon atoms and the remaining groups have 1 to 4 carbon atoms; n stands for a numeral from 0 to 200 and preferably from 10 to 100. Such diquaternary polydimethylsiloxanes are sold by GOLSCHMIDT/Germany under the commercial names Abil® Quat 3270, 3272 and 3274.

Other suitable cation-active, hair-care compounds are the cationically modified protein derivatives or cationically modified protein hydrolyzates known, for example, under the INCI designations lauryldimonium hydroxypropyl hydrolyzed wheat protein, lauryldimonium hydroxypropyl hydrolyzed casein, lauryldimonium hydroxypropyl hydrolyzed collagen, lauryldimonium hydroxypropyl hydrolyzed keratin, lauryldimonium hydroxypropyl hydrolyzed silk, soy protein or hydroxypropyltrimonium hydrolyzed wheat, hydroxypropyltrimonium hydrolyzed casein, hydroxypropyltrimonium hydrolyzed collagen, hydroxypropyltrimonium hydrolyzed keratin, hydroxypropyltrimonium hydrolyzed rice bran protein, hydroxypropyltrimonium hydrolyzed silk, hydroxypropyltrimonium hydrolyzed soy protein and hydroxypropyltrimonium hydrolyzed vegetable protein. Suitable cationically derivatized protein hydrolyzates are mixtures of substances that can be obtained, for example, by reaction of alkali-hydrolyzed, acid-hydrolyzed or enzymatically hydrolyzed proteins with glycidyltrialkylammonium salts or 3-halo-2-hydroxypropyltrialkylammonium salts. The proteins used as starting materials for the protein hydrolyzates can be of either vegetable or animal origin. Common starting materials are, for example, keratin, collagen, elastin, soy protein, rice protein, milk protein, wheat protein, silk protein or almond protein. The hydrolysis affords mixtures of sub-

stances with a molecular weight in the range from about 100 to about 50,000. The average molecular weights are usually in the range from about 500 to about 1000. Advantageously, the cationically derivatized protein hydrolyzates contain one or two long, C₈- to C₂₂-alkyl chains and correspondingly two or one short C₁- to C₄-alkyl chain. Compounds with a long alkyl chain are preferred.

An oil that can be added as care agent to the second constituent of a cleaning agent is a hydrophobic substance that is liquid at room temperature (25°C). The amount added can range from 0.1 to 20 wt.% and most preferably from 1 to 10 wt.%. The second constituent can be in the form of a pre-emulsion of the oil in water. The hydrophobic substance can be a readily volatile or non-volatile substance. The readily volatile hydrophobic substances are liquid at room temperature and preferably have a boiling point in the range from 30 to 250°C and most preferably from 60 to 220°C. Suitable are, for example, liquid hydrocarbons, liquid cyclic or linear silicones (dimethylpolysiloxanes) or mixtures of said substances. Suitable hydrocarbons are paraffins or isoparaffins with 5 to 14 carbon atoms and most preferably with 8 to 12 carbon atoms, particularly dodecane or isododecane. Suitable liquid, readily volatile silicones are the cyclic dimethylsiloxanes with 3 to 8 Si and preferably with 4 to 6 Si atoms, and in particular cyclotetradimethylsiloxane, cyclopentadimethylsiloxane or cyclohexadimethylsiloxane. Also suitable are dimethylsiloxane/methylalkylsiloxane cyclocopolymers, for example Silicone FZ 3109 produced by Union Carbide which is a dimethylsiloxane/methyloctylsiloxane cyclocopolymer. Suitable volatile linear silicones have from 2 to 9 Si atoms.

Suitable are, for example, hexamethyldisiloxane or alkyltrisiloxanes, such as hexylheptamethyltrisiloxane or octylheptamethyltrisiloxane. The nonvolatile, hydrophobic oils have a melting point below 25°C and a boiling point above 250°C and preferably above 300°C. Any oil generally known to those skilled in the art can, in principle be used for this purpose. Suitable are vegetable or animal oils, mineral oils, silicone oils or mixtures thereof. Suitable silicone oils are polydimethylsiloxanes, phenylated silicones, polyphenylmethylsiloxanes, phenyl, phenyltrimethicones, poly(C₁-C₂₀)-alkylsiloxanes, and alkylmethylsiloxanes. Also suitable are hydrocarbon oils, for example paraffin oils and isoparaffin oils, squalane, oil derived from fatty acids and polyols, particularly the triglycerides of C₁₀- to C₃₀-fatty acids. Suitable vegetable oils are, for example, sunflower oil, coconut oil, castor oil, lanolin oil, jojoba oil, corn oil and soybean oil. Particularly preferred are hydrocarbon oils and especially mineral oils (liquid paraffin) as well as vegetable oils and fatty acid triglycerides.

An embodiment of the invention is a silicone-containing two-constituent hair-care shampoo (2-in-1 shampoo). Silicone shampoos and the preparation thereof are described, for example, in WO 98/05296 and the literature cited therein. In current silicone shampoos, the insoluble silicones must be dispersed in durably stable manner which places stringent requirements on the method of preparation in terms of achieving a certain particle size. Or additives are needed to bring about

stabilization, for example thickeners which confer to the composition a separation-preventing flow limit. According to the invention, such measures may be omitted, because dispersion immediately before the application does not require a lasting stability of the dispersion. One of the constituents of the two-constituent shampoo contains an aqueous composition with at least one deterative surfactant selected from among anionic, nonionic, zwitterionic or amphoteric surfactants. The second constituent contains a water-insoluble, volatile or nonvolatile silicone compound either in the pure form or in a suitable solvent or as an aqueous pre-emulsion. In addition, preferably at least one of the two constituents contains a cationic polymer known to promote silicone deposition on the hair. Suitable surfactants, silicones and cationic polymers are, besides those mentioned hereinabove, those indicated in WO 98/05296.

Hair-care compositions that can be prepared according to the invention are obtained from a hydrophilic and a hydrophobic constituent and contain at least one active ingredient selected from among the C₁₀- to C₃₀-fatty alcohols, the above-said oils and the above-indicated cationic hair-care substances. The finished mixture is preferably a fatty alcohol dispersion. The fatty alcohols can be present in an amount from 0.1-20 wt.%, preferably from 0.5 to 10 wt.% and particularly from 1 to 8 wt.%. Suitable fatty alcohols are primary alcohols, particularly 1-alkanols with 6 to 26 carbon atoms and preferably 12 to 22 carbon atoms. The use of octanol, decanol, dodecanol or lauryl alcohol, tetradecanol or myristic alcohol, hexadecanol or cetyl alcohol, octadecanol or stearyl alcohol or a mixture of these fatty alcohols was found to be particularly advantageous. A particularly preferred fatty alcohol is cetyl alcohol. The fatty alcohols can be used as an appropriate fluid composition. For example, if they are solid at room temperature, they can be in the form of a solution or dispersion in a suitable dissolving or dispersing medium, for example in the form of an aqueous pre-emulsion. Cationic hair-care substances are those mentioned in the foregoing and they can be contained in the finished mixture in an amount from 0.01 to 10 wt.% and most preferably from 0.05 to 5 wt.%.

One embodiment concerns a creamy, highly viscous hair-care composition which after use is preferably rinsed out (rinse product). The fatty alcohol content of said composition is preferably from 0.01 to 20 wt.% and most preferably from 1 to 10 wt.%. The viscosity is preferably from 1000 to 10,000 mPa s, and most preferably from 1500 to 8,000 mPa s, determined by a dynamic viscosity-measuring method with a HAAKE VT 550 rotational viscosimeter at a temperature of 25°C with a testing spindle in accordance with German Industry Standard [DIN] 53019 (SV-DIN) at a shearing rate of 50 s⁻¹. Another embodiment concerns sprayable leave-in hair-care compositions. These compositions consist of a hydrophilic and a hydrophobic phase that are dispersed with the aid of a micromixer. They contain essentially the same ingredients as the above-said hair-care compositions. The amount of hydrophobic phase contained therein is appreciably reduced compared to that contained in the creamy hair-care compositions intended to be rinsed out so that no viscous or liquid-crystalline structures are formed. The viscosity is appreciably lower, and the products are sprayable. The fatty alcohol content of leave-in products is preferably from 0.01 to 3

wt.% and most preferably from 0.1 to 1 wt.%. The viscosity of leave-in products is preferably from 100 to 2000 mPa s and most preferably from 300 to 1500 mPa s, determined by a dynamic viscosity-measuring method with a HAAKE VT 550 rotational viscosimeter at a temperature of 25°C with a testing spindle in accordance with German Industry Standard [DIN] 53019 (SV-DIN) at a shearing rate of 50 s⁻¹. The sprayability is improved over that of conventionally prepared sprayable hair-care compositions.

Hair colorants that can be prepared according to the invention can contain in a first constituent at least one hair-coloring substance or at least one oxidation dye precursor which can be converted oxidatively into a hair dye, and in a second constituent at least one substance selected from among oxidants, hair-care substances and viscosity-increasing substances. The non-oxidative hair-coloring substances are hair-coloring inorganic pigments or soluble, organic dyes directly taken up by the hair.

The method of the invention is particularly advantageous for the preparation of oxidation colorants. As a rule, oxidation colorant consists of two constituents: (i) the dye carrier composition containing the dye precursors and (ii) the oxidant preparation, these constituents being mixed shortly before use and then applied to the hair to be colored. A higher or lower viscosity is obtained during mixing depending on the viscosity and mixing ratio of the two constituents. A higher viscosity, in particular, confers to the colorant a good adhesion. In addition, the hair dresser often needs higher viscosities for his work, for example for special strand or film techniques and for precisely aimed work with the coloring brush or accentuation brush. With the method of the invention, highly viscous mixtures with good adhesion and coloring properties can be obtained in a simple manner.

Suitable oxidants for color development are mainly hydrogen peroxide or the addition compounds thereof to urea, melamine or sodium borate in the form of a 1 to 12% and preferably 1.5 to 6% aqueous solution. The mixing ratio of colorant to oxidant depends on the concentration of the oxidant and as a rule is about 5:1 to 1:2 and preferably 1:1. The amount of oxidant in the ready-to-use mixture is preferably about 0.5 to 8 wt.% and particularly 1 to 4 wt.%.

The hair colorants can be based on a cream in emulsion form. Preferred hair colorants contain (a) water, (b) at least one waxy or fatty substance that is solid at room temperature (25°C) or an oily substance that is liquid at room temperature, c) at least one surfactant and (d) at least one direct hair dye or at least one oxidation dye precursor. The total amount of dyes or dye precursors is preferably about 0.01 to 10 wt.% and most preferably about 0.2 to 7 wt.%. Suitable direct dyes are, for example, triphenylmethane dyes, aromatic nitro dyes, azo dyes, quinone dyes and cationic or anionic dyes. Suitable are: nitro dyes (blue), nitro dyes (red), nitro dyes (yellow), basic dyes, neutral azo dyes and acid dyes.

At least one coupler and at least one developer are used as dye precursors. Developers are, for example, 1,4-diaminobenzene (p-phenylenediamine), 1,4-diamino-2-methylbenzene (p-toluylenediamine) 1,4-diamino-2-(thiophen-2-yl)benzene, 1,4-diamino-2-(thiophen-3-yl)benzene, 1,4-diamino-2-(pyridin-3-yl)benzene, 2,5-diaminobiphenyl, 1,4-diamino-2-methoxymethylbenzene, 1,4-diamino-2-aminomethylbenzene, 1,4-diamino-2-hydroxymethylbenzene, 4-[di(2-hydroxyethyl)amino]aniline, 1,4-diamino-2-(1-hydroxyethyl)benzene 1,4-diamino-2-(2-hydroxyethyl)benzene, 1,3-bis[(4-aminophenyl)(2-hydroxyethyl)amino]-2-propanol, 1,8-bis(2,5-diaminophenoxy)-3,6-dioxaoctane, 2,5-diamino-4'-hydroxy-1,1'-biphenyl, 2,5-diamino-2'-trifluoromethyl-1,1'-biphenyl, 2,4',5'-triamino-1,1'-biphenyl, 4-aminophenol, 4-amino-3-methylphenol, 4-methylaminophenol, 4-amino-2-(aminomethyl)phenol, 4-amino-2-[(2-hydroxyethyl)amino]methylphenol, 4-amino-2-(methoxymethyl)phenol, 5-aminosalicylic acid, 2,4,5,6-tetraaminopyrimidine, 2,5,6-triamino-4-(1H)-pyrimidone, 4,5-diamino-1-(2-hydroxyethyl)-1H-pyrazole, 4,5-diamino-1-(1-pentyl)-1H-pyrazole, 4,5-diamino-1-(phenylmethyl)-1H-pyrazole, 4,5-diamino-1-(4-methoxyphenyl)methyl-1H-pyrazole, 2-aminophenol, 2-amino-6-methylphenol, 2-amino-5-methylphenol, 1,2,4-trihydroxybenzene, 2,4-diaminophenol, 1,4-dihydroxybenzene and 2-[(4-aminophenyl)amino]methyl-1,4-di-aminobenzene.

Couplers are, for example: (3-dimethylaminophenyl)urea, 2,6-diaminopyridine, 2-amino-4-[(2-hydroxyethyl)amino]anisole, 2,4-diamino-1-fluoro-5-methylbenzene, 2,4-diamino-1-ethoxy-5-methylbenzene, 2,4-diamino-1-(2-hydroxyethoxy)-5-methylbenzene, 3-amino-6-methoxy-2-(methylamino)pyridine, 3,5-diamino-2,6-dimethoxypyridine, 1,3-diaminobenzene, 2,4-diamino-1-(2-hydroxyethoxy)benzene, 1,3-diamino-4-(3-hydroxypropoxy)benzene, 1,3-diamino-4-(2-methoxyethoxy)benzene, 1,3-di(2,4-diaminophenoxy)propane, 2,6-bis(2-hydroxyethyl)aminotoluene, 5-amino-2-methylphenol, 5-amino-4-fluoro-2-methylphenol, 3-amino-2,4-dichlorophenol, 3-amino-2-chloro-6-methylphenol, 3-aminophenol, 5[(2-hydroxyethyl)amino]-2-methylphenol, 2-amino-3-hydroxypyridine, 2,6-dihydroxy-3,4-dimethyl-pyridine, 5-amino-4-chloro-2-methylphenol, 1-naphthol, 1,5-dihydroxynaphthalene, 1,7-dihydroxynaphthalene, 2,7-dihydroxynaphthalene, 2-methyl-1-naphthol acetate, 1,3-dihydroxybenzene, 1-chloro-2,4-dihydroxybenzene, 1,3-dihydroxy-2-methylbenzene, 5-[(2-hydroxyethyl)amino]-1,3-benzodioxol, 3,4-diaminobenzoic acid, 3,4-dihydro-6-hydroxy-1,4(2H)-benzoxazine, 3-methyl-1-phenyl-5-pyrazolone, 5,6-dihydroxyindole, 5,6-dihydroxyindoline, 6-hydroxyindole, and 2,3-indolinedione.

Known dyes commonly used for hair coloring are those described, for example, in E. Sagarin "Cosmetics, Science and Technology", Interscience Publishers Inc., New York (1957), pages 503 ff, in H. Janistyn "Handbuch der Kosmetika und Riechstoffe" [Handbook of Cosmetics and Perfumes], volume 3 (1973), pages 388 ff and K. Schrader "Grundlagen und Rezepturen der Kosmetika" [Fundamentals and Formulations of Cosmetics], 2nd edition (1989), pages 782-815.

Suitable hair-coloring pigments are coloring materials that are practically insoluble in the application medium and can be inorganic or organic. Inorganic-organic mixed pigments are also usable.

The pigments are preferably nanopigments. The preferred particle size is from 1 to 200 μm , particularly from 3 to 150 μm and most preferably from 10 to 100 μm . Inorganic pigments are preferred. The inorganic pigments can be of natural origin, for example prepared from chalk, ocher, umber, green earth, burned terra di Siena or graphite. The pigments can be white, for example titanium dioxide or zinc oxide, or black, for example black iron oxide, they can be brightly colored, for example ultramarine or red iron oxide, they can be lustrous, confer a metallic effect, or nacreous pigments as well as fluorescent or phosphorescent pigments, preferably at least one pigment being a colored, nonwhite pigment. Suitable are metal oxides, metal hydroxides or metal oxide hydrates, mixed phase pigments, sulfur-containing silicates, metal sulfides, complex metal cyanides, metal sulfates, metal chromates, metal molybdates and metals themselves (bronze pigments). Particularly well suited are titanium dioxide (CI 77891), black iron oxide (CI 77499), yellow iron oxide (CI 77492), red and brown iron oxide (CI 77491), manganese violet (CI 77742), ultramarine (sodium aluminum sulfosilicates, CI 77007, Pigment Blue 29), chromium oxide hydrate (CI 77289), Prussian blue (ferric ferrocyanide, CI 77510) and carmine (cochineal). Particularly preferred are mica-based pigments coated with a metal oxide or a metal oxychloride such as titanium dioxide or bismuth oxychloride and possibly with other color-imparting substances such as iron oxides, Prussian blue, ultramarine, carmine etc., the color of such pigments being determined by varying the thickness of the coating. Such pigments are marketed in Germany by Merck under the commercial names of, for example, Rona®, Colorona®, Dichrona® and Timiron®. Organic pigments are, for example, the natural pigments sepia, gamboge, bone charcoal, Cassel brown, indigo, chlorophyll and other vegetable pigments. Synthetic organic pigments are anthraquinoids, indigoids, dioxazine pigments, quinacridone pigments, phthalocyanine pigments, isoindolinone pigments, perylene pigments and perinone pigments, metal complex pigments, alkali blue pigments and diketopyrrolopyrrol pigments.

For non-oxidative colorants based on direct dyes, the pH of the colorants of the invention is in the range of about 5 to 10 and preferably about 6 to 9, whereas for oxidative colorants based on oxidation dye precursors the pH is in the range from about 6 to 12 and preferably from 9 to 11, the pH of the ready-to-use oxidation hair colorant (namely of the mixture of the hair colorant of the invention and the oxidant) is from about 5.5 to 10 and preferably from 6 to 9. Depending on the composition and the pH desired for the colorant, the pH is preferably adjusted with ammonia or an organic amine, for example a glucamine, aminomethylpropanol, monoethanolamine or triethanolamine, an inorganic base, for example sodium hydroxide, potassium hydroxide, sodium carbonate or calcium hydroxide, or with an organic or inorganic acid, for example lactic acid, citric acid, acetic acid or phosphoric acid.

By the method of the invention, cosmetic sunscreens can also be prepared just before use, such mixtures containing at least one active sunscreen ingredient. Particularly preferred are disperse sunscreens containing either insoluble light-protection agents in finely dispersed form or disperse sunscreens consisting of an oil or lipid phase and an aqueous phase, namely O/W or W/O

emulsions. Current sunscreens are difficult to stabilize so as to meet the stringent requirements for long-term stability, and, moreover, a selection of a specially adapted emulsifier mixture is needed. The two-constituent sunscreens of the invention which are dispersed just before use have the advantage that the requirements on the emulsifier system are substantially lower, that other, in particular more skin-friendly, emulsifiers can be used, that the amount of emulsifiers can be reduced or that the emulsifier can be totally or partly omitted. The light-protection agent can be selected from among UV light-absorbing inorganic pigments, inorganic nanopigments and oil-soluble or water-soluble organic, UVA-, UVB- or UVA/UVB filter substances. Suitable filter substances are, for example, 2-phenylbenzimidazole-5-sulfonic acid and salts thereof, cinnamic acid derivatives, salicylic acid derivatives, camphor derivatives, triazine derivatives, benzophenone derivatives, dibenzo-ylmethane derivatives, β,β -diphenyl acrylate derivatives, p-aminobenzoic acid derivatives, menthyl anthranilate, polymers with light-protective action and silicones with light-protective action. The sunscreen agents prepared according to the invention are characterized by an improved light-protection factor.

According to the method of the invention, cosmetic, dermatological or pharmaceutical skin creams can also be prepared just before use. In this case, the product is an emulsion formed by an aqueous phase and a hydrophobic phase and contains at least one skin-care, dermatological or pharmaceutical active ingredient, and the dispersion of the phases is carried out in a micromixer. As a rule, the skin cream contains water, a fatty or waxy substance, an emulsifier and an active ingredient. The active ingredient can be a cosmetic oils, emollient, vitamin, vitamin derivative, provitamine, essential fatty acid, sphingolipid, phospholipid, ceramide, betain, panthenol, a pharmaceutical agent etc. Skin creams prepared according to the invention are characterized by an improved skin feel, improved distribution of the active ingredients, better takeup of the active ingredients by the skin and a reduction in the amount required. Moreover, the amount of emulsifiers can be reduced, which reduces the risk of skin irritation.

According to the method of the invention, it is also possible to prepare hair preparations or cosmetic skin preparations containing at least one powdered solid in finely dispersed form, for which the dispersion of the solid is performed in a micromixer. Suitable solids are, for example, pigments, nacreous pigments, talc, mica, kaolin, zinc oxides, titanium oxides, precipitated calcium carbonate, magnesium carbonate or magnesium hydrogen carbonate, silicic acid, glass beads, ceramic beads, powdered polymers etc. The solids are preferably in an appropriate presuspension.

According to the method of the invention, active ingredient preparations containing perfume oils and fragrances can also be prepared just before use. In this case, a first constituent contains a nonperfumed active ingredient composition and a second constituent contains at least one perfume oil or fragrance. In this manner, it is possible to use kinds and amounts of fragrances which in combination with the active ingredient preparation would otherwise not be stable over a long

period of time. Moreover, the user can, when using exchangeable package parts for the individual constituents, combine different active ingredient compositions containing different perfumes.

The constituents can have other active ingredients and additives besides those already mentioned. Suitable active ingredients and additives are, for example, other deterative anionic, nonionic or amphoteric surfactants, antidandruff agents, hair-care and skin-care substances such as quaternized alkylamines, cationic polymers of natural or synthetic origin, proteins and derivatives thereof, such as hydrolyzates of collagen, keratin, silk protein and wheat protein as well as silicone compounds. Moreover, the following can be used: perfume oils, dyes, opacifiers, such as ethylene glycol distearate; hair-conditioning agents such as synthetic or natural phospholipids or quaternary derivatives of starch or cellulose; dissolution promoters such as short-chain alcohols, for example ethanol, n-propanol, isopropanol, or glycols such as butylene glycol or propylene glycol; amino acids, for example, histidine, glycine, alanine, threonine, arginine, cysteine and the derivatives thereof, for example fatty acid condensation products or quaternary products; other active ingredients such as plant extracts, vitamins, allantoin, chitosan, preservatives etc.

The advantages of the products mixed according to the invention consist of an optimum particle size distribution of the homogenized particles, optimum distribution of the disperse phase in the external phase, a high active surface area, a reduced amount of emulsifier needed and thus improved skin compatibility, improved efficacy of the cosmetic active ingredients and auxiliary agents, improved crystallization behavior and improved rheological properties. The hair-treatment and skin-treatment agents prepared according to the invention have the advantage that they make possible a more uniform deposition of active ingredients on the hair or on the skin than do conventionally prepared products. The narrower particle size distribution improves the take-up by the hair.

EXAMPLES

The following exemplary formulations can be used in combination with a packaging unit of the invention.

Example 1 - Hair-styling gel from two low-viscosity phases.

Constituent 1:

0.5 g	of carbomer (cross-linked polyacrylic acid, Carbopol® 980)
40 g	of water

Constituent 2:

2 g	of polyvinylpyrrolidone (PVP K90)
3 g	of glycerol
0.4 g	of aminomethylpropanol
0.4 g	of PEG-40 HYDROGENATED CASTOR OIL (Cremophor® CO410)
0.2 g	of perfume
15 g	of ethanol
to 50 g	water

Example 2 - Oxidative hair colorant

Constituent 1:

17 g	of cetearyl alcohol
1.9 g	of sodium laurylsulfate
1.4 g	of sodium lauryl ether sulfate
2.1 g	of lanolin alcohol
6.1 g	of glyceryl stearate
0.4 g	of sodium cocylisethionate
1.4 g	of ammonia
6 g	of isopropanol
0.6 g	of sodium sulfite
0.3 g	of EDTA
0.06 g	of p-aminophenol hydrochloride
0.65 g	of p-toluylenediamine sulfate
0.26 g	of resorcinol

0.3 g of perfume oil
to 100 g water

Constituent 2:

6% hydrogen peroxide solution
or hydrogen peroxide emulsion:

10.0 g of cetylstearyl alcohol
1.5 g of cholesterol
4.0 g of sodium lauryl alcohol diethylene glycol ether sulfate,
28% aqueous solution
35.0 g of hydrogen peroxide, 35% aqueous solution
0.3 g of perfume
to 100.0 g water

Example 3 - Shampoo

Constituent 1:

30 g of sodium lauryl ether sulfate
8 g of cocamidopropylbetaine
3 g of ethylene glycol distearate
0.35 g of sodium benzoate
0.15 g of sodium formate
0.2 g of sodium chloride
to 100 g water

Constituent 2:

Cationic polymer and/or perfume and/or silicone oil
in an appropriate solvent or as aqueous pre-emulsion

Example 4 - Sunscreen agent

Oil phase	INCI/EU	Wt. %
Parsol 1789	BUTYL METHOXYDIBENZOYLMETHANE	0.30
Neo Heliopan AV/OA	OCTYL METHOXYCINNAMATE	10.00
Hostaphat KL 340 N	TRILAURETH-4 PHOSPHATE	0.60
Hostacerin DGI	POLYGLYCERYL-2 SESQUIISOSTEARATE	0.70
Phenoxetol	PHENOXYETHANOL	1.00
Cetiol 868	OCTYL STEARATE	5.00
Primol 352	MINERAL OIL	5.00
Abil Wax 9801D	CETYL DIMETHICONE	-----
<i>Aqueous phase:</i>		
Carbopol 2984	CARBOMER	0.30
Sodium hydroxide	SODIUM HYDROXIDE	0.06
Glycerol, 86%	GLYCEROL	5.00
Water, demineralized	AQUA	to 100

Example 5 - Sunscreen agent

Oil phase	INCI/EU	Wt. %
Parsol 1789	BUTYL METHOXYDIBENZOYLMETHANE	0.30
Neo Heliopan AV/OA	OCTYL METHOXYCINNAMATE	10.00
Hostaphat KL 340 N	TRILAURETH-4 PHOSPHATE	0.60
Hostacerin DGI	POLYGLYCERYL-2 SESQUIISOSTEARATE	0.70
Phenoxetol	PHENOXYETHANOL	1.00
Cetiol 868	OCTYL STEARATE	9.00
Primol 352	MINERAL OIL	-----
Abil Wax 9801D	CETYL DIMETHICONE	1.00
<i>Aqueous phase:</i>		
Carbopol 2984	CARBOMER	0.30
Sodium hydroxide	SODIUM HYDROXIDE	0.06
Glycerol, 86%	GLYCEROL	5.00
Water, demineralized	AQUA	to 100

Example 6 - Sunscreen agent

Lipid phase	INCI/EU	Wt. %
Parsol 1789	BUTYL METHOXYDIBENZOYLMETHANE	1.50
PHB-methyl ester	METHYLPARABEN	0.20
Neo Heliopan AV/OA	OCTYL METHOXYCINNAMATE	10.00
Neo Heliopan Type 303	OCTOCRYLENE	10.00
Finsolv TN	C12-15 ALKYL BENZOATE	2.50
Eutanol G	OCTYLDODECANOL	10.00
Antaron V 216	PVP/HEXADECENE COPOLYMER	2.00
Vitamin E acetate	TOCOPHERYL ACETATE	0.50
Perfume	PERFUME	0.30
Abil Wax 9801D	CETYL DIMETHICONE	0.50
<i>Aqueous phase:</i>		
Carbopol 1382	ACRYLATES/C10-30 ALKYL ACRYLATE CROSSPOLYMER	0.45
Colorona Oriental Beige 17237	MICA (and) CI 77891 (and) CI 77491)	0.05
Glycerol 86%	GLYCEROL	5.00
Edeta BD	DISODIUM EDTA	0.01
Sodium hydroxide	SODIUM HYDROXIDE	0.18
D-Panthenol	PANTHENOL	0.50
Water, demineralized	AQUA	to 100
Dekaben LMB	IODOPROPYNYL BUTYLCARAMATE	0.50

Example 7 - O/W Body lotion

<i>Oil phase:</i>	INCI/EU	Wt. %
Paraffin oil subliquidum	PARAFFINUM LIQUIDUM	7.50
Cetacol V	CETEARYL ISONONANOATE	2.50
Avocado oil	PERSEA GRATISSIMA	2.00
Hostaphat 340 D	TRILAURETH-4 PHOSPHATE	3.50
Methylparaben	METHYLPARABEN	0.20
Propylparaben	PROPYLPARABEM	0.05
Perfume	PARFUM	0.50

Aqueous phase:

Carbopol 2984	CARBOMER	0.30
Sodium hydroxide	SODIUM HYDROXIDE	0.06
Phenoxetol	PHENOXYETHANOL	0.60
Glycerol 86 %	GLYCEROL	5.00
Water, demineralized	AQUA	to 100

Example 8 - W/O Body lotion

<i>Oil phase:</i>	INCI/EU	Wt. %
-------------------	---------	-------

Paraffin oil subliquidum	PARAFFINUM LIQUIDUM	15.00
Cetiol 868	ETHYLHEXYL STEARATE	12.00
Dehymuls PGPH	POLYGLYCERYL-2	2.00
	DIPOLYHYDROXY STEARATE	
Zincum N29	ZINC STEARATE	0.50
Vitamin E - Acetate	TOCOPHERYL ACETATE	0.50
Methylparaben	METHYLPARABEN	0.20
Propylparaben	PROPYLPARABEN	0.05
Perfume	PERFUME	0.50

Aqueous phase:

Zinc sulfate 7-hydrate	ZINC SULFATE	
Phenoxetol	PHENOXYETHANOL	0.60
Glycerol 86 %	GLYCEROL	8.00
Water, demineralized	AQUA	to 100

List of Reference Numerals

1	disk
2	inlet opening
3	linking channel
4	outlet opening
5	mixing zone
6	microstructure unit
7	part channel
8	recess
9	flow-through opening
10	built-in structures
11	housing
12	through-hole
12a	fluid inlet
13	additional part channel
13a	closure
14	fixing element
15	cover
16	fluid outlet
17	external container
18 a,b	internal container